Exhibit 12 (a)

Northwest transect sample 5269-B01-05-BG-G0041 (Figure 24) represents the subsurface soil (6-12”) from 19 McKinley Ave. It contains large amount of high temperature (thermogenic) byproducts. Some of the black coal-like material is covered with white fine ash. Non-spherical particles contain iron oxide.

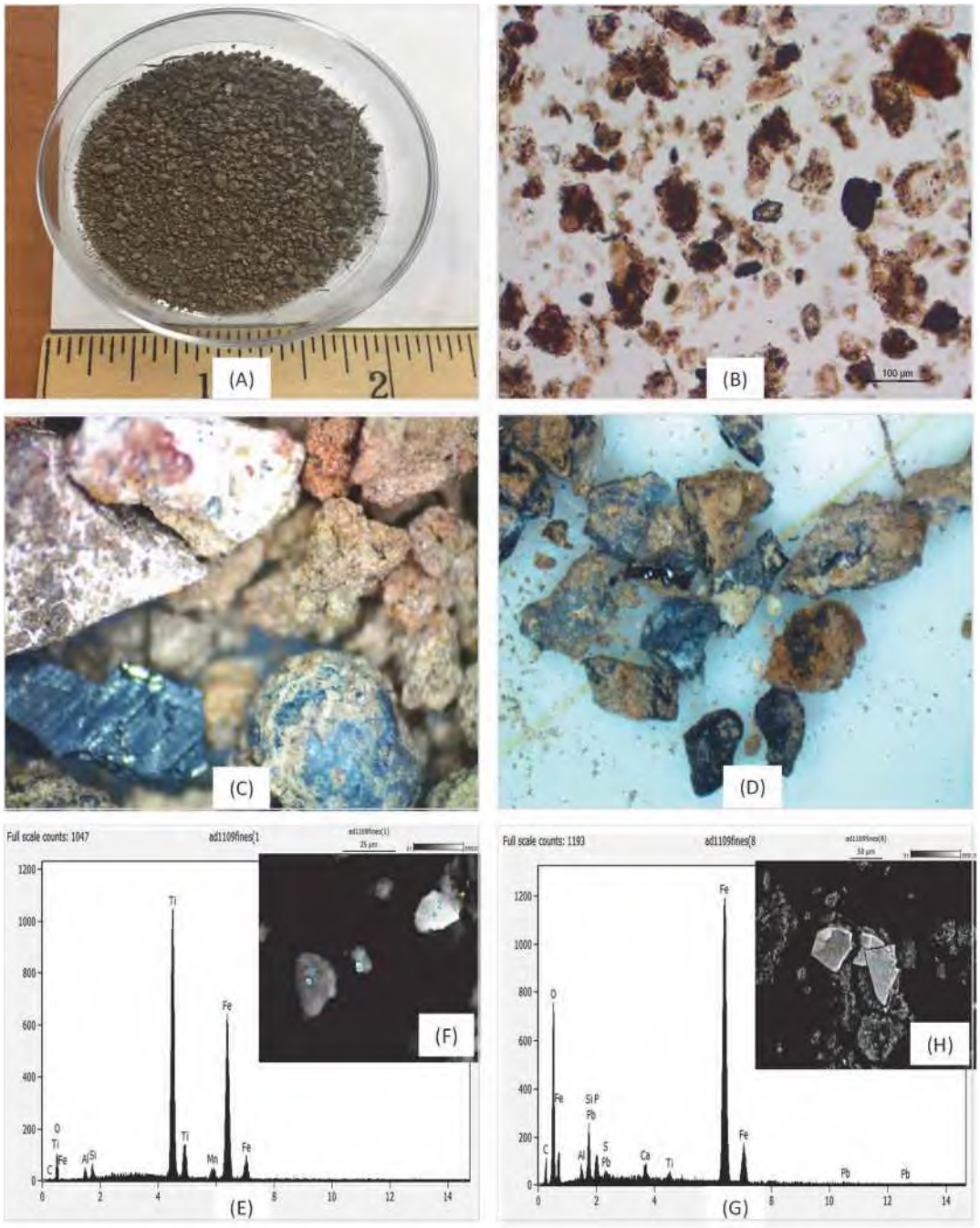

Figure 24. Northwest Transect Soil Sample 5269-B01-05-BG-G0041: (A) photo; (B) PLM photomicrograph; (C) stereo microscopy photomicrograph 7X; (D) stereo microscopy photomicrograph; (E) EDS spectra and (F) SEM image; and (G) EDS spectra and (H) SEM image.

Northwest transect sample 5631-B01-09-AG-G0074 (Figure 25) contained soil minerals and black glassy slag-like particles. The black particles were coated with layer of reddish brown flaky material. Slag fragments are larger than 100 um and compositionally distinct from On-site slags based upon the absence of Cu, Zn, and Pb even among disaggregated fragments.

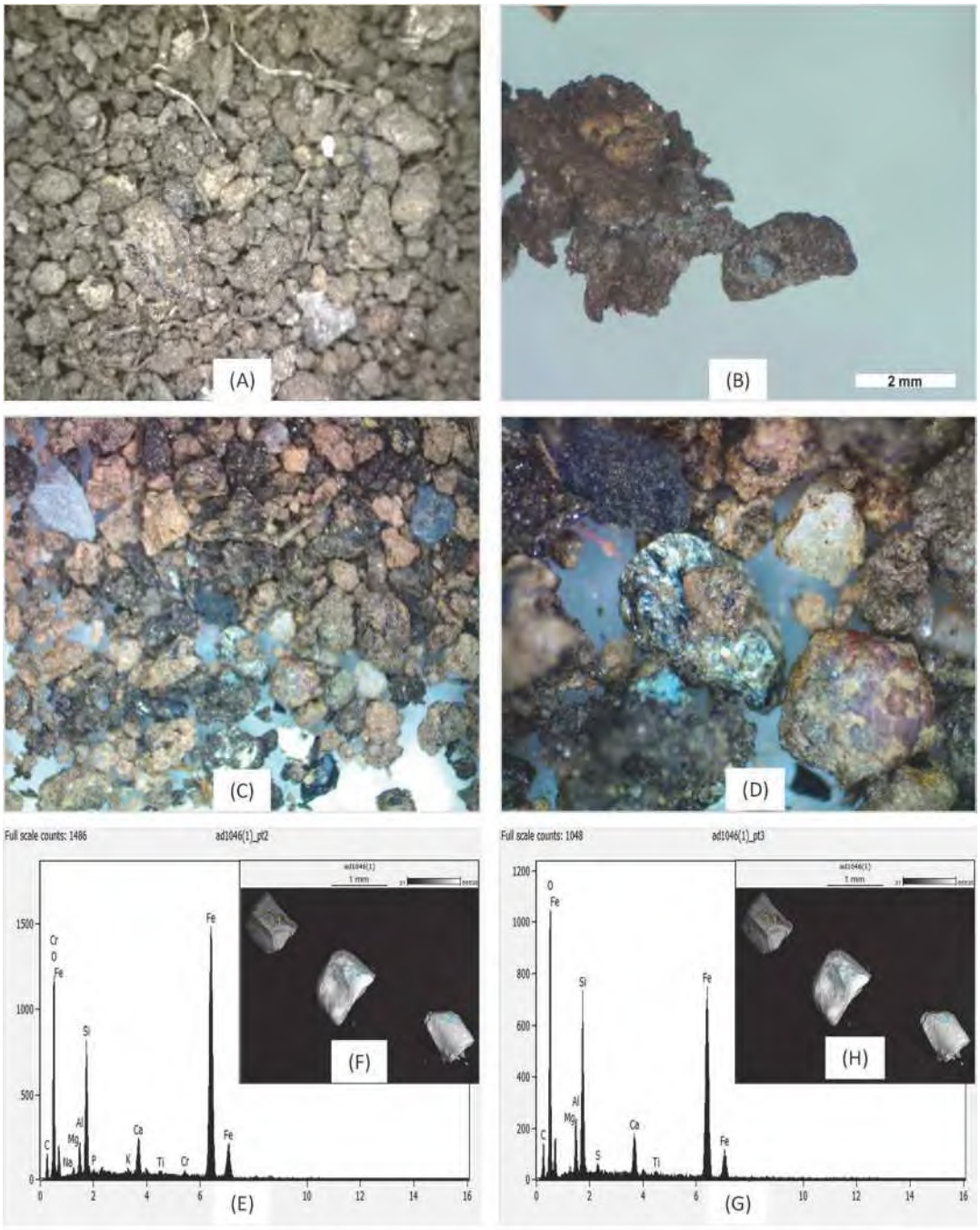

Figure 25: Northwest Transect Soil Sample 5631-B01-09-AG-G0074: (A) photo; (B) PLM photomicrograph; (C) stereo microscopy photomicrograph 7X; (D) stereo microscopy photomicrograph; (E) EDS spectra and (F) SEM image; and (G) EDS spectra and (H) SEM image.

North transect sample 6408-B01-05-BG-G0043 (Figure 26) contained soil minerals, paint chips, glass, black porous cinder, coal and coke. This sample contains a wide variety of particles from many sources, none of which matches the On-site slags.

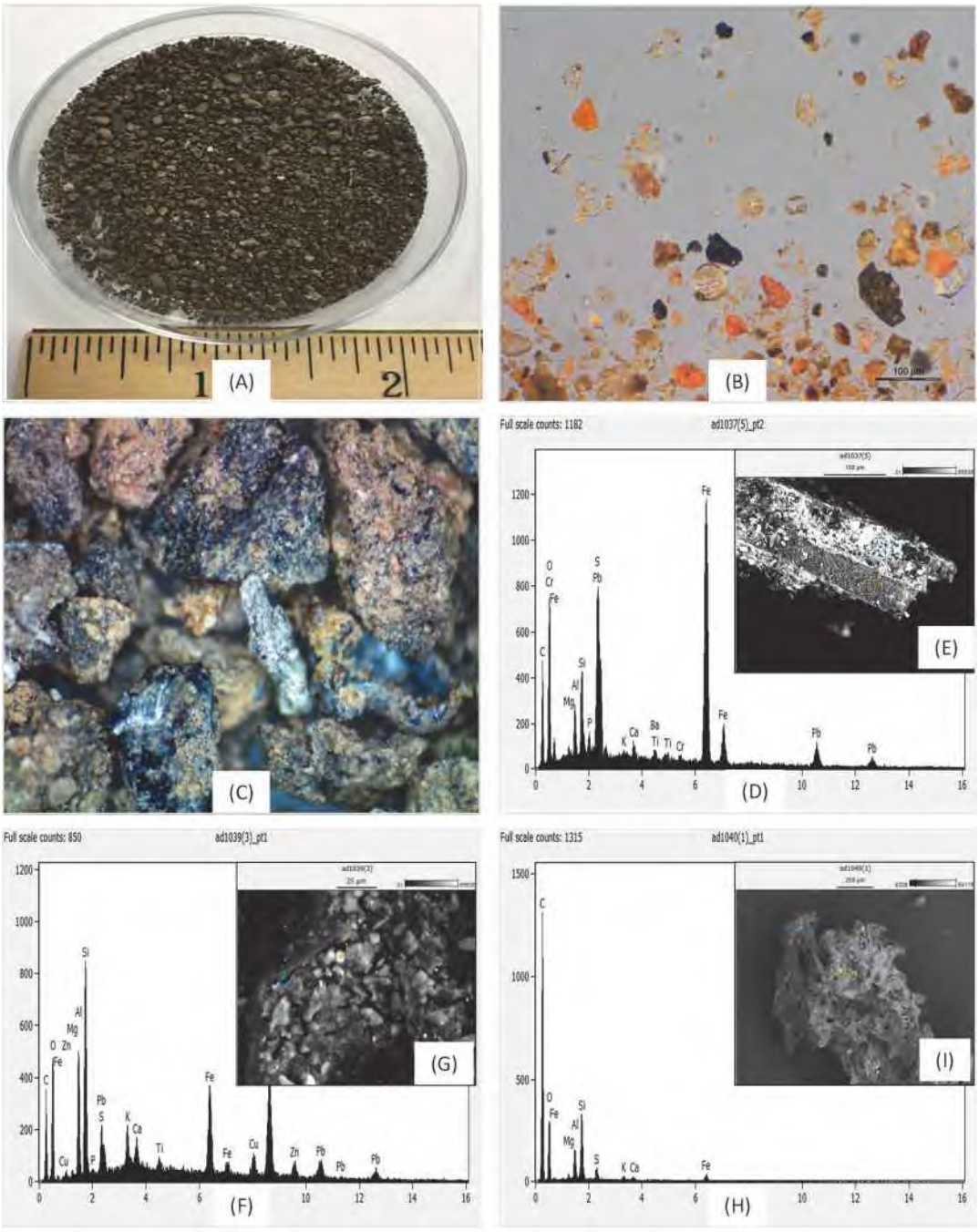

Figure 26: North Transect Soil Sample 6408-B01-05-BG-G0043: (A) photo; (B) stereo microscopy photomicrograph 7X; (C) stereo microscopy photomicrograph 40X; (D) paint chip EDS spectra and (E) SEM image; (F) coal particle EDS spectra and (G) SEM image; and (H) coke EDS spectra and (I) SEM image.

North transect sample 6723-B01-01-AG-G0001 (Figure 27) contained combustion residue materials, such as hollow siliceous spheres, coal ash with spherical gas voids and small pieces of coal-like fragments. Similar materials were observed in majority of the inspected soil samples. High concentrations of Pb are observed in solder spheres.

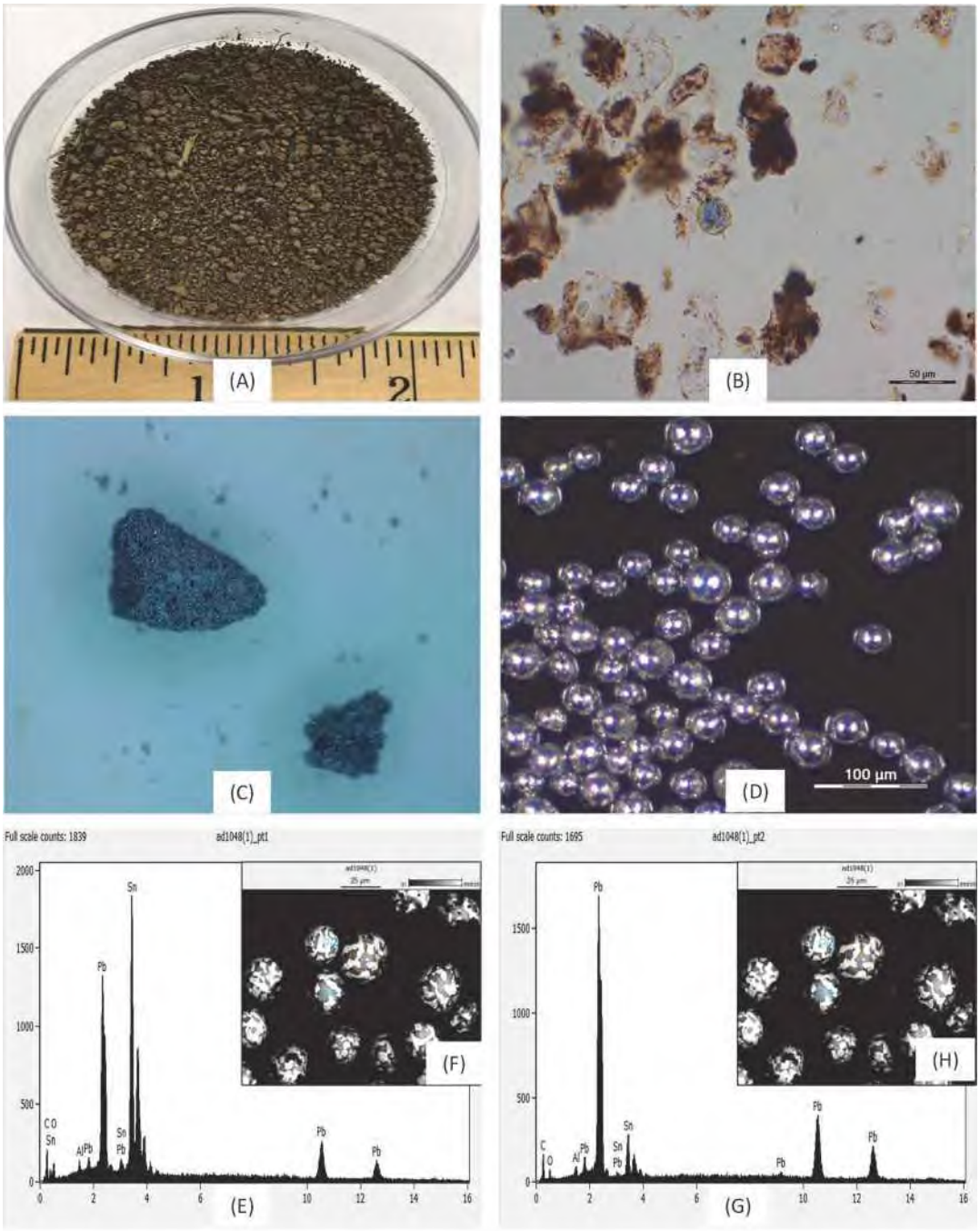

Figure 27: North Transect Soil Sample 6723-B01-01-AG-G0001: (A) photo; (B) stereo microscopy photomicrograph 7X; (C) stereo microscopy photomicrograph 20X; (D) stereo microscopy photomicrograph 200X; (E) broad scan solder sphere EDS spectra and (F) SEM image; and (G) focused scan of solder sphere EDS spectra and (H) SEM image.

Northeast transect sample 7209-B01-03-BG-G0020 (Figure 28) presents as brown angular soil particles containing soil minerals, rust/metal flakes, paint chips, black porous cinder-like particles and colored flakes of paint. Strong Pb signals are present in paint chips exhibiting layers of green, tan, white, red, and others. Pb specks appear on coal particle.

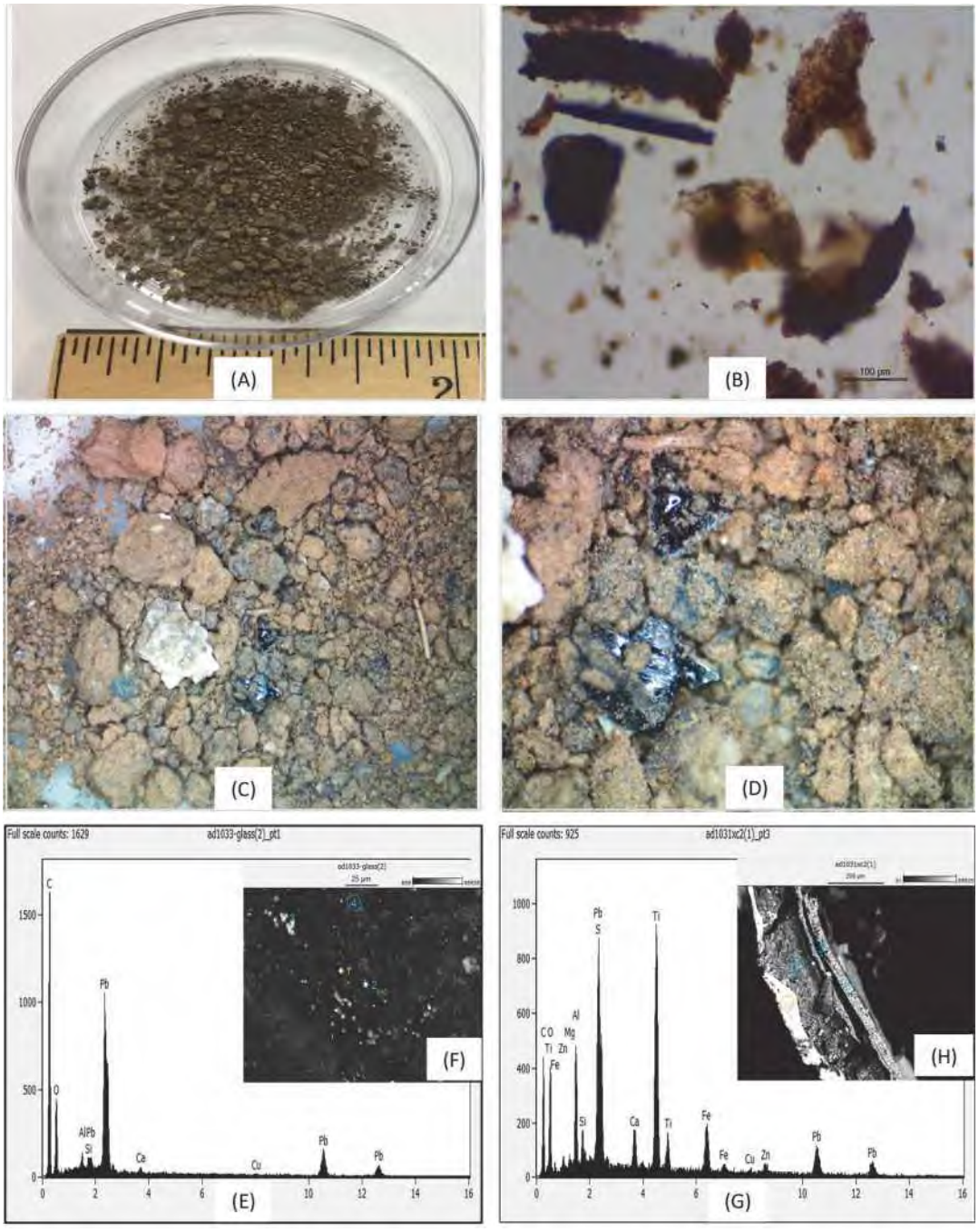

Figure 28: Northeast Transect Soil Sample 7209-B01-03-BG-G0020: (A) photo; (B) stereo microscopy photomicrograph of paint chips; (C) whole sample stereo microscopy photomicrograph 7X; (D) whole sample stereo microscopy photomicrograph 20X; (E) paint chip exterior EDS spectra and (F) SEM image; and (G) paint chip interior EDS spectra and (H) SEM image.

Northeast transect sample 7337-B01-03-BG-G0020 (Figure 29) contains soil minerals, green color stained glass, black glassy slag particles and coal-like materials. Small lead inclusions are present on slag and small Pb particles adhere to coal.

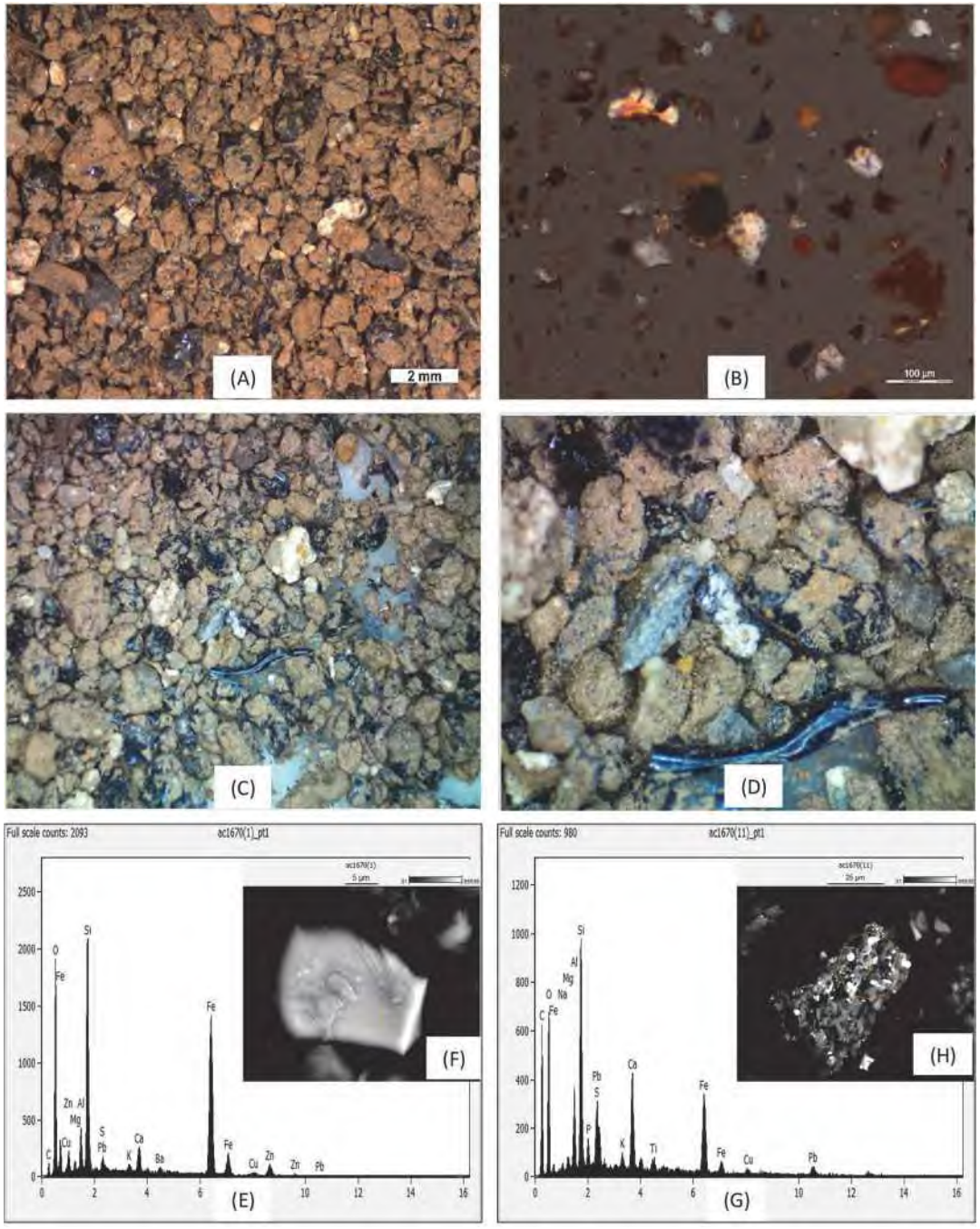

Figure 29: Northeast Transect Soil Sample 7337-B01-03-BG-G0020: (A) photo; (B) PLM photomicrograph; (C) stereo microscopy photomicrograph 7X; (D) stereo microscopy photomicrograph 20X; (E) slag type 1 EDS spectra and (F) SEM image; and (G) slag type 2 EDS spectra and (H) SEM image.

Table 3. Forensic Microscopy Results.

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
1	1	PARCEL 7-1	Yes		Yes	Yes	Yes	Yes					Yes				
2	1	PARCEL 7-2	Yes		Yes	Yes	Yes	Yes					Yes				
3	1	CHROME-01	Yes	Yes	Yes	Yes	Yes	Yes	Yes			Yes					No
4	1	CHROME-02	Yes	Yes	Yes	Yes	Yes	Yes	Yes				Yes			Yes	No
5	1	1001-G04-04-NG-G1855	Yes		Yes	Yes	Yes		Yes	Possible							No
6	1	1001-G13-03-IG-G2434	Yes		Yes	Yes	Yes		Yes				Yes				No
7	1	1001-G13-04-AG-G0960	Yes		Yes	Yes	Yes		Yes			Yes					No
8	1	1001-G13-05-IG-G2465	Yes						Yes								
9	1	1001-G13-06-IG-G2475	Yes						Yes								
10	1	1001-G14-01-MG-G2036	Yes						Yes								
11	1	1053-B01-10-AG-G0043	Yes						Yes								
12	1	2006-G23-09-AG-G2707	Yes						Yes								
13	1	3019-G03-04-AG-G0944	Yes		Yes	Yes	Yes		Yes				Possible				No
14	1	3019-G07-06-AG-G0231	Yes						Yes								
15	1	3022-B01-04-AG-G0017	Yes						Yes								
16	1	3024-B01-10-AG-G0070	Yes						Yes								
17	1	4143-G01-06-AG-G1223	Yes		Yes	Yes	Yes		Yes		Yes	Yes					No
18	1	4143-G05-06-AG-G1405	Yes		Yes	Yes	Yes		Yes				Possible				No
19	1	4143-G09-03-AG-G1561	Yes		Yes	Yes	Yes		Yes			Yes					No
20	1	4143-G16-08-AG-G1881	Yes		Yes	Yes	Yes		Yes			Yes					No
21	1	4143-G38-04-AG-G3316	Yes						Yes								
22	1	5631-B01-09-AG-G0074	Yes						Yes								
23	1	7337-B01-03-BG-G0020	Yes	Yes	Yes	Yes	Yes		Yes			Yes	Yes				No
24	1	7355-B01-08-AG-G0065	Yes						Yes								
25	2	5269-B01-01-BG-G0002	Yes						Yes								
26	2	5269-B01-02-AG-G0012	Yes						Yes								
27	2	5269-B01-02-BG-G0013	Yes						Yes								
28	2	5269-B01-03-AG-G0022	Yes						Yes								
29	2	5269-B01-03-BG-G0023	Yes						Yes								
30	2	5269-B01-04-AG-G0031	Yes						Yes								
31	2	5269-B01-04-BG-G0032	Yes						Yes								
32	2	5269-B01-04-BG-G0033	Yes						Yes								
33	2	5269-B01-04-CG-G0034	Yes						Yes								
34	2	5269-B01-05-BG-G0041	Yes		Yes	Yes	Yes		Yes	Yes		Yes					No
35	2	5269-B01-07-AG-G0058	Yes						Yes								
36	2	5269-B01-08-AG-G0068	Yes						Yes								
37	2	5269-B01-09-AG-G0077	Yes						Yes								
38	2	5269-B01-09-BG-G0078	Yes						Yes								
39	2	5271-B01-01-AG-G0001	Yes						Yes								
40	2	5271-B01-01-BG-G0002	Yes						Yes								
41	2	5271-B01-01-CG-G0003	Yes						Yes								
42	2	5271-B01-01-DG-G0004	Yes						Yes								
43	2	5271-B01-03-AG-G0019	Yes						Yes								
44	2	5271-B01-04-BG-G0029	Yes						Yes								
45	2	5271-B01-05-BG-G0038	Yes						Yes								
46	2	5271-B01-05-DG-G0040	Yes						Yes								
47	2	5271-B01-06-AG-G0045	Yes						Yes								
48	2	5271-B01-06-BG-G0046	Yes						Yes								
49	2	5271-B01-06-DG-G0048	Yes						Yes								
50	2	5271-B01-07-BG-G0057	Yes						Yes								
51	2	5271-B01-08-AG-G0065	Yes						Yes								
52	2	5271-B01-10-AG-G0084	Yes						Yes								
53	2	5271-B01-10-BG-G0085	Yes						Yes								
54	2	5271-B01-10-CG-G0086	Yes						Yes								
55	2	5271-B01-10-DG-G0087	Yes						Yes								
56	2	5285-B01-01-BG-G0003	Yes						Yes								
57	2	5285-B01-02-AG-G0010	Yes						Yes								
58	2	5285-B01-02-CG-G0012	Yes						Yes								
59	2	5285-B01-02-DG-G0013	Yes						Yes								
60	2	5285-B01-03-AG-G0020	Yes						Yes								
61	2	5285-B01-03-CG-G0022	Yes						Yes								
62	2	5285-B01-04-BG-G0030	Yes						Yes								
63	2	5285-B01-05-BG-G0038	Yes						Yes								
64	2	5285-B01-06-BG-G0046	Yes						Yes								
65	2	5285-B01-10-BG-G0081	Yes						Yes								
66	2	5287-B01-01-BG-G0002	Yes						Yes								
67	2	5287-B01-02-AG-G0011	Yes						Yes								
68	2	5287-B01-03-AG-G0021	Yes						Yes								
69	2	5287-B01-05-AG-G0042	Yes						Yes								
70	2	5287-B01-05-CG-G0045	Yes						Yes								

Table 3. Forensic Microscopy Results (continued).

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
71	2	5287-B01-07-BG-G0063	Yes						Yes								
72	2	5287-B01-08-AG-G0070	Yes						Yes								
73	2	5287-B01-08-BG-G0071	Yes						Yes								
74	2	5287-B01-09-AG-G0078	Yes		Yes	Yes	Yes		Yes	Yes							No
75	2	5368-B01-01-BG-G0002	Yes						Yes								
76	2	5368-B01-03-AG-G0019	Yes						Yes								
77	2	5368-B01-03-BG-G0020	Yes						Yes								
78	2	5368-B01-04-AG-G0028	Yes						Yes								
79	2	5368-B01-04-BG-G0029	Yes						Yes								
80	2	5368-B01-04-BG-G0030	Yes						Yes								
81	2	5368-B01-04-CG-G0031	Yes						Yes								
82	2	5368-B01-04-DG-G0032	Yes						Yes								
83	2	5368-B01-05-AG-G0037	Yes						Yes								
84	2	5368-B01-05-BG-G0038	Yes						Yes								
85	2	5368-B01-05-CG-G0039	Yes						Yes								
86	2	5368-B01-06-AG-G0046	Yes						Yes								
87	2	5368-B01-07-AG-G0055	Yes						Yes								
88	2	5368-B01-07-AG-G0056	Yes		Yes	Yes	Yes		Yes	Yes							No
89	2	5368-B01-07-BG-G0057	Yes						Yes								
90	2	5457-B01-01-AG-G0001	Yes						Yes								
91	2	5457-B01-01-BG-G0003	Yes						Yes								
92	2	5457-B01-03-BG-G0021	Yes						Yes								
93	2	5457-B01-04-AG-G0030	Yes						Yes								
94	2	5457-B01-04-CG-G0032	Yes						Yes								
95	2	5457-B01-06-BG-G0050	Yes						Yes								
96	2	5457-B01-07-BG-G0059	Yes						Yes								
97	2	5457-B01-08-AG-G0067	Yes						Yes								
98	2	5461-B01-01-AG-G0001	Yes						Yes								
99	2	5461-B01-03-BG-G0019	Yes						Yes								
100	2	5461-B01-04-BG-G0028	Yes						Yes								
101	2	5461-B01-05-AG-G0036	Yes						Yes								
102	2	5461-B01-05-BG-G0037	Yes						Yes								
103	2	5461-B01-06-AG-G0045	Yes						Yes								
104	2	5544-B01-02-AG-G0012	Yes						Yes								
105	2	5544-B01-02-BG-G0013	Yes						Yes								
106	2	5544-B01-03-BG-G0021	Yes						Yes								
107	2	5544-B01-05-BG-G0038	Yes						Yes								
108	2	5553-B01-03-BG-G0020	Yes						Yes								
109	2	5553-B01-09-AG-G0073	Yes						Yes								
110	2	5553-B01-10-AG-G0081	Yes						Yes								
111	2	5631-B01-01-AG-G0001	Yes						Yes								
112	2	5631-B01-01-BG-G0002	Yes						Yes								
113	2	5631-B01-02-AG-G0011	Yes						Yes								
114	2	5631-B01-02-BG-G0012	Yes						Yes								
115	2	5631-B01-03-AG-G0019	Yes						Yes								
116	2	5631-B01-04-AG-G0028	Yes						Yes								
117	2	5631-B01-04-BG-G0029	Yes						Yes								
118	2	5631-B01-04-CG-G0031	Yes						Yes								
119	2	5631-B01-04-DG-G0032	Yes						Yes								
120	2	5631-B01-05-AG-G0037	Yes						Yes								
121	2	5631-B01-05-BG-G0038	Yes						Yes								
122	2	5631-B01-06-AG-G0045	Yes						Yes								
123	2	5631-B01-06-BG-G0046	Yes						Yes								
124	2	5631-B01-06-CG-G0047	Yes						Yes								
125	2	5631-B01-06-DG-G0048	Yes						Yes								
126	2	5631-B01-07-AG-G0055	Yes						Yes								
127	2	5631-B01-07-AG-G0056	Yes						Yes								
128	2	5631-B01-07-BG-G0057	Yes						Yes								
129	2	5631-B01-08-AG-G0065	Yes						Yes								
130	2	5631-B01-08-BG-G0066	Yes						Yes								
131	2	5631-B01-09-AG-G0074	Yes		Yes	Yes	Yes		Yes	Possible							No
132	2	5631-B01-09-BG-G0075	Yes						Yes								
133	2	5631-B01-10-AG-G0084	Yes						Yes								
134	2	5631-B01-10-BG-G0085	Yes		Yes	Yes	Yes		Yes				Possible				No
135	2	5631-B01-10-CG-G0086	Yes						Yes								
136	2	5631-B01-10-DG-G0087	Yes						Yes								
137	2	5633-F01-01-AG-G0001	Yes						Yes								
138	2	5633-F01-01-BG-G0003	Yes						Yes								
139	2	5633-F01-01-CG-G0004	Yes						Yes								
140	2	5633-F01-01-DG-G0006	Yes						Yes								

Table 3. Forensic Microscopy Results (continued).

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
141	2	5633-F01-03-AG-G0023	Yes						Yes								
142	2	5633-F01-03-CG-G0026	Yes						Yes								
143	2	5633-F01-03-DG-G0027	Yes						Yes								
144	2	5633-F01-04-AG-G0033	Yes						Yes								
145	2	5633-F01-04-BG-G0034	Yes						Yes								
146	2	5633-F01-05-AG-G0042	Yes						Yes								
147	2	5633-F01-05-BG-G0043	Yes						Yes								
148	2	5633-F01-05-BG-G0044	Yes						Yes								
149	2	5633-F01-06-AG-G0052	Yes						Yes								
150	2	5633-F01-06-BG-G0053	Yes						Yes								
151	2	5633-F01-07-AG-G0061	Yes						Yes								
152	2	5633-F01-07-BG-G0062	Yes						Yes								
153	2	5633-F01-07-DG-G0064	Yes						Yes								
154	2	5633-F01-08-AG-G0069	Yes						Yes								
155	2	5633-F01-08-BG-G0071	Yes						Yes								
156	2	5633-F01-09-AG-G0078	Yes						Yes								
157	2	5633-F01-09-BG-G0079	Yes						Yes								
158	2	5633-F01-09-CG-G0080	Yes						Yes								
159	2	5633-F01-09-DG-G0082	Yes						Yes								
160	2	5633-F01-10-AG-G0088	Yes						Yes								
161	2	5633-F01-10-BG-G0089	Yes						Yes								
162	2	6015-B01-06-BG-G0047	Yes						Yes								
163	2	6015-B01-07-BG-G0057	Yes						Yes								
164	2	6015-B01-09-AG-G0074	Yes						Yes								
165	2	6015-B01-10-BG-G0084	Yes						Yes								
166	2	6020-B01-04-BG-G0031	Yes						Yes								
167	2	6105-B01-01-BG-G0002	Yes						Yes								
168	2	6105-B01-03-BG-G0021	Yes						Yes								
169	2	6105-B01-04-AG-G0030	Yes						Yes								
170	2	6105-B01-07-BG-G0059	Yes						Yes								
171	2	6105-B01-08-AG-G0067	Yes						Yes								
172	2	6105-B01-08-BG-G0069	Yes						Yes								
173	2	6105-B01-09-BG-G0077	Yes						Yes								
174	2	6202-B01-02-BG-G0013	Yes						Yes								
175	2	6202-B01-03-BG-G0022	Yes						Yes								
176	2	6202-B01-04-AG-G0030	Yes						Yes								
177	2	6202-B01-04-BG-G0031	Yes						Yes								
178	2	6202-B01-04-CG-G0032	Yes						Yes								
179	2	6202-B01-04-DG-G0033	Yes						Yes								
180	2	6202-B01-05-BG-G0039	Yes						Yes								
181	2	6202-B01-06-AG-G0047	Yes						Yes								
182	2	6202-B01-07-BG-G0057	Yes						Yes								
183	2	6202-B01-08-AG-G0066	Yes						Yes								
184	2	6202-B01-08-BG-G0067	Yes						Yes								
185	2	6202-B01-08-CG-G0068	Yes						Yes								
186	2	6202-B01-10-BG-G0085	Yes						Yes								
187	2	6408-B01-01-BG-G0002	Yes						Yes			Yes					
188	2	6408-B01-05-AG-G0042	Yes		Yes	Yes	Yes		Yes				Possible				No
189	2	6408-B01-05-BG-G0043	Yes		Yes	Yes	Yes		Yes	Yes		Yes					No
190	2	6408-B01-06-BG-G0051	Yes						Yes								
191	2	6408-B01-08-AG-G0068	Yes						Yes								
192	2	6408-B01-09-BG-G0079	Yes						Yes								
193	2	6419-B01-01-BG-G0003	Yes						Yes								
194	2	6508-B01-04-AG-G0028	Yes	Yes					Yes	Possible							No
195	2	6508-B01-04-BG-G0030	Yes						Yes								
196	2	6508-B01-04-CG-G0031	Yes						Yes								
197	2	6508-B01-05-AG-G0037	Yes	Yes					Yes		Yes						No
198	2	6508-B01-05-CG-G0039	Yes						Yes								
199	2	6508-B01-07-AG-G0055	Yes	Yes					Yes		Yes						No
200	2	6508-B01-08-AG-G0065	Yes	Yes					Yes	Yes							No
201	2	6508-B01-08-BG-G0066	Yes						Yes								
202	2	6508-B01-09-AG-G0074	Yes						Yes								
203	2	6514-B01-04-BG-G0029	Yes						Yes								
204	2	6514-B01-06-BG-G0046	Yes		Yes	Yes	Yes		Yes	Possible							No
205	2	6522-B01-01-AG-G0001	Yes						Yes								
206	2	6522-B01-02-AG-G0010	Yes						Yes								
207	2	6522-B01-02-BG-G0011	Yes						Yes								
208	2	6522-B01-03-BG-G0020	Yes						Yes								
209	2	6522-B01-04-AG-G0028	Yes						Yes								
210	2	6522-B01-04-BG-G0029	Yes						Yes								

Table 3. Forensic Microscopy Results (continued).

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
211	2	6522-B01-09-AG-G0074	Yes						Yes								
212	2	6632-B01-01-AG-G0001	Yes						Yes								
213	2	6632-B01-01-AG-G0001	Yes						Yes								
214	2	6632-B01-01-BG-G0002	Yes						Yes								
215	2	6632-B01-03-AG-G0019	Yes						Yes								
216	2	6632-B01-03-CG-G0021	Yes						Yes								
217	2	6632-B01-03-DG-G0022	Yes						Yes								
218	2	6632-B01-04-BG-G0029	Yes						Yes								
219	2	6632-B01-08-AG-G0063	Yes						Yes								
220	2	6632-B01-08-BG-G0065	Yes						Yes								
221	2	6632-B01-08-CG-G0066	Yes						Yes								
222	2	6632-B01-08-DG-G0067	Yes						Yes								
223	2	6632-B01-09-AG-G0073	Yes						Yes								
224	2	6632-B01-09-CG-G0075	Yes						Yes								
225	2	6632-B01-09-DG-G0076	Yes						Yes								
226	2	6632-B01-10-AG-G0083	Yes						Yes								
227	2	6643-B01-02-BG-G0012	Yes						Yes								
228	2	6643-B01-03-AG-G0019	Yes						Yes								
229	2	6643-B01-03-BG-G0020	Yes						Yes								
230	2	6643-B01-03-CG-G0021	Yes						Yes								
231	2	6643-B01-05-AG-G0038	Yes						Yes								
232	2	6643-B01-06-AG-G0046	Yes						Yes								
233	2	6643-B01-07-AG-G0057	Yes						Yes								
234	2	6716-B01-01-AG-G0001	Yes						Yes								
235	2	6716-B01-01-CG-G0003	Yes						Yes								
236	2	6716-B01-01-DG-G0004	Yes						Yes								
237	2	6716-B01-02-AG-G0010	Yes						Yes								
238	2	6716-B01-09-AG-G0075	Yes						Yes								
239	2	6723-B01-01-AG-G0001	Yes		Yes	Yes	Yes		Yes	Yes							No
240	2	6723-B01-02-BG-G0012	Yes						Yes								
241	2	6723-B01-03-BG-G0020	Yes						Yes								
242	2	6723-B01-04-BG-G0029	Yes						Yes								
243	2	6723-B01-07-AG-G0056	Yes						Yes								
244	2	6723-B01-08-AG-G0067	Yes						Yes								
245	2	6723-B01-08-BG-G0068	Yes		Yes	Yes	Yes		Yes		Yes						No
246	2	6723-B01-09-AG-G0076	Yes						Yes								
247	2	6723-B01-10-AG-G0086	Yes						Yes								
248	2	7015-B01-07-BG-G0058	Yes		Yes	Yes	Yes		Yes				Possible				No
249	2	7015-B01-09-AG-G0075	Yes						Yes								
250	2	7015-B01-09-BG-G0076	Yes						Yes								
251	2	7015-B01-09-CG-G0077	Yes						Yes								
252	2	7015-B01-09-DG-G0079	Yes						Yes								
253	2	7209-B01-01-AG-G0001	Yes						Yes								
254	2	7209-B01-03-BG-G0020	Yes		Yes	Yes	Yes		Yes	Yes		Yes	Possible				No
255	2	7310-B01-01-BG-G0002	Yes						Yes								
256	2	7310-B01-09-BG-G0076	Yes						Yes								
257	2	7319-B01-01-BG-G0002	Yes						Yes								
258	2	7319-B01-07-AG-G0057	Yes						Yes								
259	2	7337-B01-01-AG-G0001	Yes						Yes								
260	2	7337-B01-01-BG-G0002	Yes						Yes								
261	2	7337-B01-02-AG-G0010	Yes		Yes	Yes	Yes		Yes	Yes							No
262	2	7337-B01-02-BG-G0011	Yes		Yes	Yes	Yes		Yes			Yes	Yes				No
263	2	7337-B01-02-CG-G0013	Yes		Yes	Yes	Yes		Yes			Yes	Yes				No
264	2	7337-B01-02-CG-G0013	Yes						Yes								
265	2	7337-B01-02-DG-G0014	Yes						Yes								
266	2	7337-B01-03-AG-G0019	Yes						Yes								
267	2	7337-B01-03-CG-G0021	Yes						Yes								
268	2	7337-B01-03-CG-G0021	Yes						Yes								
269	2	7337-B01-03-DG-G0022	Yes						Yes								
270	2	7337-B01-04-AG-G0028	Yes						Yes								
271	2	7337-B01-04-BG-G0029	Yes						Yes								
272	2	7337-B01-04-BG-G0030	Yes						Yes								
273	2	7337-B01-05-BG-G0039	Yes						Yes								
274	2	7337-B01-05-CG-G0040	Yes						Yes								
275	2	7337-B01-05-CG-G0040	Yes						Yes								
276	2	7337-B01-05-DG-G0041	Yes						Yes								
277	2	7337-B01-06-AG-G0047	Yes						Yes								
278	2	7337-B01-07-AG-G0056	Yes						Yes								
279	2	7337-B01-07-AG-G0057	Yes						Yes								
280	2	7337-B01-09-AG-G0075	Yes						Yes								

Table 3. Forensic Microscopy Results (continued).

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
281	2	7337-B01-09-BG-G0076	Yes						Yes								
282	2	7337-B01-09-CG-G0077	Yes						Yes								
283	2	7337-B01-09-CG-G0077	Yes						Yes								
284	2	7337-B01-09-DG-G0079	Yes						Yes								
285	2	7350-B01-05-AG-G0038	Yes						Yes								
286	2	7355-B01-02-AG-G0011	Yes						Yes								
287	2	7355-B01-03-AG-G0021	Yes						Yes								
288	2	7355-B01-05-AG-G0039	Yes						Yes								
289	2	7355-B01-05-BG-G0040	Yes						Yes								
290	2	7355-B01-07-BG-G0057	Yes						Yes								
291	2	7355-B01-08-BG-G0066	Yes						Yes								
292	2	7355-B01-09-AG-G0073	Yes						Yes								
293	2	7355-B01-09-BG-G0074	Yes						Yes								
294	2	7355-B01-10-AG-G0081	Yes						Yes								
295	2	7355-B01-10-BG-G0082	Yes						Yes								
296	2	7401-B01-03-BG-G0020	Yes						Yes								
297	2	7401-B01-07-AG-G0056	Yes						Yes								
298	2	7401-B01-07-AG-G0057	Yes						Yes								
299	2	7401-B01-07-CG-G0059	Yes						Yes								
300	2	7401-B01-10-BG-G0085	Yes						Yes								
301	2	7409-B01-01-AG-G0001	Yes						Yes								
302	2	7409-B01-01-BG-G0002	Yes						Yes								
303	2	7409-B01-04-AG-G0028	Yes						Yes								
304	2	7409-B01-04-BG-G0030	Yes						Yes								
305	2	7409-B01-04-DG-G0032	Yes						Yes								
306	2	7409-B01-07-AG-G0057	Yes						Yes								
307	2	7409-B01-08-BG-G0068	Yes						Yes								
308	2	7409-B01-10-AG-G0086	Yes						Yes								
309	2	7409-B01-10-CG-G0088	Yes						Yes								
310	2	7410-B01-01-BG-G0002	Yes						Yes								
311	2	7410-B01-06-AG-G0050	Yes						Yes								
312	2	7412-B01-03-AG-G0022	Yes						Yes								
313	2	7412-B01-04-AG-G0031	Yes						Yes								
314	2	7412-B01-06-AG-G0049	Yes						Yes								
315	2	7412-B01-07-BG-G0061	Yes						Yes								
316	3	6514-B01-02-AG-G0011	Yes						Yes								
317	3	6514-B01-02-BG-G0012	Yes						Yes								
318	3	6514-B01-05-AG-G0037	Yes						Yes								
319	3	6514-B01-06-AG-G0045	Yes						Yes								
320	3	6514-B01-09-AG-G0075	Yes						Yes								
321	3	6514-B01-09-BG-G0076	Yes						Yes								
322	3	7350-B01-04-AG-G0028	Yes						Yes								
323	3	7350-B01-05-BG-G0039	Yes						Yes								
324	3	7350-B01-06-AG-G0046	Yes						Yes								
325	3	7350-B01-07-AG-G0057	Yes						Yes								
326	3	7350-B01-10-AG-G0086	Yes						Yes								
327	3	6202-B01-02-AG-G0012	Yes						Yes								
328	3	6202-B01-03-AG-G0021	Yes						Yes								
329	3	6202-B01-07-AG-G0056	Yes						Yes								
330	3	4094-CP09-07-AG-G0041	Yes						Yes								
331	3	4094-CP09-07-BG-G0042	Yes						Yes								
332	3	7310-B01-07-AG-G0056	Yes						Yes								
333	3	7310-B01-07-AG-G0057	Yes						Yes								
334	3	7209-B01-05-AG-G0038	Yes		Yes	Yes	Yes		Yes	Yes							No
335	3	3110-F01-06-EG-G0079	Yes		Yes	Yes	Yes	Yes	Yes	Yes				Yes			No
336	3	3110-F01-10-EG-G0098	Yes						Yes								
337	3	4129-B01-04-FG-G0026	Yes						Yes								
338	3	4129-B01-02-GG-G0073	Yes						Yes								
339	3	4129-B01-04-GG-G0081	Yes						Yes								
340	3	4143-G29-03-BG-G2667	Yes						Yes								
341	3	4143-G39-05-FG-G3425	Yes						Yes								
342	3	3017-G17-01-IG-G2063	Yes						Yes								
343	3	4063-B01-04-EG-G0057	Yes						Yes								
344	3	4095-CP08-01-EG-G0006	Yes						Yes								
345	3	4143-G04-07-AG-G1322	Yes						Yes								
346	3	4143-G05-05-BG-G1398	Yes						Yes								
347	3	4143-G05-06-BG-G1406	Yes						Yes								
348	3	4143-G08-06-CG-G1496	Yes						Yes								
349	3	4143-G08-08-BG-G1514	Yes						Yes								
350	3	4143-G09-04-BG-G1573	Yes						Yes								

Table 3. Forensic Microscopy Results (continued).

No.	Phase	Sample	NF	UMass	MVA			Geller	Fill	Pb Source				As Source			USMR
			SM	SEMEDS	SM	PLM	SEMEDS	EMPA	Present	Paint	Solder	Specks	Slag	Natural	Aqueous	Slag	Emission
351	3	4143-G09-05-CG-G1582	Yes						Yes								
352	3	4143-G21-02-DG-G2108	Yes						Yes								
353	3	4143-G28-08-DG-G2621	Yes		Yes	Yes	Yes	Yes	Yes						Yes		No
354	3	4143-G39-05-EG-G3424	Yes						Yes								
355	3	5368-B01-01-AG-G0001	Yes						Yes								
356	3	5368-B01-10-AG-G0083	Yes						Yes								
357	3	5544-B01-10-AG-G0082	Yes						Yes								
358	3	6015-B01-07-BG-G0058	Yes						Yes								
359	3	6723-B01-01-BG-G0002	Yes						Yes								
360	3	6723-B01-09-BG-G0077	Yes						Yes								
361	3	7206-B01-07-AG-G0058	Yes						Yes								
362	3	7206-B01-07-BG-G0060	Yes						Yes								
363	3	7206-B01-08-AG-G0068	Yes						Yes								
364	3	7209-B01-05-BG-G0039	Yes						Yes								
365	3	7310-B01-03-AG-G0019	Yes						Yes								
366	3	7337-B01-07-BG-G0058	Yes						Yes								
367	3	7350-B01-07-AG-G0056	Yes						Yes								
368	3	2030-B01-02-GG-G0098	Yes						Yes								
369	3	3017-G14-09-DG-G0545	Yes						Yes								
370	3	3017-G17-01-DG-G0562	Yes					Yes	Yes								No
371	3	3017-G17-05-DG-G0595	Yes						Yes								
372	3	3065-F01-10-CG-G0047	Yes						Yes								
373	3	3066-F01-01-AG-G0001	Yes						Yes								
374	3	3066-F01-10-AG-G0043	Yes						Yes								
375	3	3066-F01-10-BG-G0044	Yes						Yes								
376	3	4000-G03-04-CG-G0159	Yes		Yes	Yes	Yes	Yes	Yes	Yes							No
377	3	4063-B01-03-BG-G0010	Yes						Yes								
378	3	4063-B01-04-DG-G0016	Yes						Yes								
379	3	4063-B01-06-DG-G0024	Yes						Yes								
380	3	4058-G01-04-DG-G0019	Yes		Yes	Yes	Yes	Yes	Yes			Yes					No
381	3	4089-B01-04-AG-G0015	Yes						Yes								
382	3	4089-B01-04-BG-G0016	Yes		Yes	Yes	Yes	Yes	Yes	Yes				Possible	Possible		No
383	3	4089-B01-05-AG-G0019	Yes						Yes								
384	3	4089-B01-05-BG-G0020	Yes						Yes								
385	3	4089-B01-06-AG-G0024	Yes						Yes								
386	3	4092-F01-01-BG-G0002	Yes						Yes								
387	3	4094-CP09-07-CG-G0043	Yes						Yes								
388	3	4133-CP03-03-AG-G0014	Yes						Yes								
389	3	4133-CP03-03-BG-G0016	Yes						Yes								
390	3	4133-CP03-05-AG-G0029	Yes						Yes								
391	3	4133-CP03-05-BG-G0030	Yes						Yes								
392	3	4129-B01-03-DG-G0018	Yes					Yes	Yes							Yes	No
393	3	4129-B01-04-EG-G0025	Yes						Yes								
394	3	4143-G28-05-CG-G2592	Yes						Yes								
395	3	4143-G28-09-CG-G2630	Yes						Yes								
396	3	6508-B01-07-BG-G0057	Yes						Yes								
397	3	6716-B01-01-BG-G0002	Yes						Yes								
398	3	6716-B01-09-BG-G0076	Yes						Yes								
399	3	7337-B01-06-CG-G0049	Yes						Yes								
400	3	7337-B01-06-DG-G0050	Yes						Yes								
401	3	7337-B01-07-CG-G0059	Yes						Yes								
402	3	7337-B01-07-DG-G0060	Yes						Yes								
403	3	7355-B01-01-AG-G0001	Yes		Yes	Yes	Yes		Yes	Yes							No
404	3	7015-B01-07-AG-G0057	Yes						Yes								
405	3	2010-B01-24-B-FS sub	Yes	Yes	Yes	Yes	Yes		Yes			Yes					No
406	3	2010-B01-24-T-FS sub	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes					No
407	3	2014-A 12 inch-FS sub	Yes	Yes	Yes	Yes	Yes		Yes			Yes					No
408	3	2010-shed P	Yes	Yes	Yes	Yes	Yes			Yes							No
409	3	78 Union shed P	Yes	Yes	Yes	Yes	Yes			Yes							No
410	Ref	Cinder	Yes	Yes	Yes	Yes	Yes										No
411	Ref	Black Fragment #2	Yes	Yes	Yes	Yes	Yes										No
412	Ref	Light Grey Fragment	Yes	Yes	Yes	Yes	Yes										No
413	Ref	Black Fragment #1	Yes	Yes	Yes	Yes	Yes										No
414	Ref	Brick Fragment	Yes	Yes	Yes	Yes	Yes										No

6. Expert Opinions

The narrative that follows contains opinions that are based upon the data and information available to me at the time of this report and reflect my best professional judgment to a reasonable degree of scientific certainty. If additional data or information were to become available, I reserve the right to evaluate any impact on my opinions, and modify or supplement my opinions accordingly.

This report relies upon several lines of evidence. The chemistry and sample collection data compiled by ELM (on-site) and Arcadis (off-site) provided a framework for selecting archive samples for more detailed forensic analysis. Samples were sorted by primary contaminants of concern (COCs, *i.e.,* Pb and As) and representative samples with high and low concentrations were evaluated to determine which particle types coincided with higher COC concentrations. The database included additional information concerning the approximate year during which building construction began. Older construction dates imply the use of older construction debris and longer periods of anthropogenic activity, such as carpentry, metallurgy, plumbing, renovation, painting, combustion, and others. Four hundred and nine (409) samples were examined as part of this phased forensic investigation (Table 1).

Site inspections during the excavation of several properties in the AOC provide direct evidence concerning the nature and extent of fill. Distinct coloration and composition visually distinguished the multiple layers of fill on each property inspected. Mixtures of soil, construction debris, and combustion byproducts appeared in all layers above the native red soil. The layer thickness varied between approximately 2 to 10 inches, but never appeared mixed.

Forensic microscopy provided a systematic exploration of particle morphology and composition. This direct scientific evidence is used to identify heavy metal sources when models or other theories conflict about the origins of these contaminants. The microscopy techniques employed in this report characterize a wide range of particles extending from large particles evident with the naked eye to micron-sized particles well within the range of soot and thermogenic emissions. State of the art, forensic microscopy techniques used in this report provide multiple, complementary lines of evidence concerning the presence or absence of particulate emissions from the former USMR facility in residential soils collected from AOC and transect properties. These site histories, field observations, and microscopic lines of evidence serve as the basis for the following expert opinions.

6.1 There is no evidence that particulates originating from the former USMR facility air emissions are present in the transect samples collected outside the AOC, and the analytical techniques used as part of this study are capable of identifying these particulates if they are present.

On-site samples demonstrate the composition and morphological features of particles from the former USMR facility. The chemical fingerprint of copper emission particles consist of O, Fe, and Pb with lower proportions of Cu, Zn, Ca, and Al. The particle morphology consists of small particles (< 75 um) with rounded edges. One would expect air emissions from the USMR facility to have a similar chemical fingerprint and particle sizes less than 75 um in the transect area. It is also expected that this chemical signature would be evident on progressively larger particle sizes in the AOC as one approached the former USMR facility. The absence of these chemical signatures among particles less than 75 um in the transect area and larger particles in the AOC demonstrate that air emissions from the former USMR facility are not the cause of elevated Pb and As in the study area.

An alternative explanation for elevated Pb and As is readily apparent – localized historical ground sources, such as urban fill, automotive emissions, construction and building materials (solder and

paint), agricultural and/or residential pesticide applications. The overwhelming majority of transect samples consist of urban fill (Table 3). Environmental regulators and scientists agree that urban fill is associated with elevated concentrations of heavy metals and PAHs derived from mixtures of soil construction debris, roadway materials, and other anthropogenic wastes, such as coal ash, cinders, and other thermogenic byproducts. Heavy metals improve the performance characteristics, such as durability, strength, and flexibility, for many building and construction materials. Fill containing construction debris, especially older construction debris, commonly contained heavy metals from these materials in the form of paint, screws, flashing, plumbing, and electrical equipment. In addition, thermogenic processes, such as fire and incineration effectively concentrate heavy metals in the ash and cinder byproducts. For these reasons, regulators in NJ, MA, IL, and others permit high regulatory limits for soils containing fill with construction debris and combustion byproducts (MassDEP, 1992; NJDEP, 1993; NJDEP, 2005; NJDEP, 2011; NJDEP, 2013; NJDEP, 2015; Swanson and Lamie, 2010; and USGS, 2003).

Transect samples exhibiting the highest concentrations of Pb and As generally fall within the concentration ranges expected for urban background and fill. This forensic evaluation employed the NJDEP benchmarks for urban fill, which suggest that concentrations of Pb should be less than 617 mg/kg and As should be less than 48.9 mg/kg (NJDEP, 1993). These benchmarks provided context for the analysis in Phase 1 of this work, but they did not limit the selection of soil samples in Phases 2 and 3, which extended the forensic microscopy analysis preferentially into the Transect Area. Collectively, forensic microscopy demonstrated that the transect soils contain fill that are compositionally and morphologically distinct from particles associated with the former USMR facility. Forensic microscopy further demonstrated that Pb was widely observed in particles greater than 100 um in the form of paint chips and slag. Arsenic was detected in the AOC as natural minerals or deposits on Fe containing particles larger than 100 um. Consequently, Pb and As containing particles are too large for atmospheric distribution. Smaller particles (<100 um) containing Pb are attributed to solder or Pb specks consistent with paint or vehicular emissions from leaded gasoline.

6.2 Slag distribution is not uniform. It varies in depth, thickness, morphology and composition from property to property in the study area. Slag variability is attributable to multiple sources. Lead is found in some, but not all slag fragments.

The on-site slag presents as black glassy porous and angular fragments with high proportions of Al, Si, O, and Fe with minor proportions of Zn, Cu, and Pb. Although not unique to copper smelting, these features are sufficient for distinguishing on-Site slags from those generated by off-site sources.

The slags observed among the AOC and transect samples present as glassy alumina silicate with pores and ranges in shape, size, and trace impurities (Fe, Mg, Ca, K, Ti, Cu, and others). Some of these slags contain minor proportions of Pb and others do not. Slags appear as amorphous fragments that are sometimes angular, spherical, tubular, or combinations of multiple morphologies. Slag particles are commonly observed in AOC samples, but less commonly observed among transect samples. The composition of the slag varies significantly in the transect area.

Most of the slag fragments observed in this investigation are attributed to urban fill, although it cannot be ruled out that some of the fill in the AOC area could contain slag from the former USMR copper smelter.

The slag particle sizes are universally larger than 100 um with the exception of smaller fragments that are compositionally similar to proximal larger slag fragments; that is, smaller fragments likely erode from larger slag fragments. This observation indicates that slag particles found in transect

soils are not consistent with atmospheric distribution.

6.3 Lead is attributable to multiple sources in the study area. Sources of lead that were identified by the microscopy include lead-based paint, solder, slag fragments, other non-native fill materials, and suspected combustion emissions from vehicles burning leaded gasoline.

Paint chips containing Pb and other elements are present in soil samples from many properties. These particles were generally 1 mm to 10 mm in size, coated with fine soil particles, and observed at multiple depth intervals. Paint chips exhibiting these features are consistent with urban fill with some enrichment likely from historical activities on individual parcels (*e.g.*, paint chips originating from deterioration of painted structures on the property).

Solder presents as aggregates generally 1 mm to 10 mm in size and shares many visual features with slag; that is, they present as angular particles with pores. These fragments disaggregate into numerous spheres 0.01 mm to 0.03 mm in size with the application of mild pressure. Although small, these spheres consisted of pure Pb and Sn and mix readily with the soil. Solder is consistent with construction debris attributed to urban fill with some enrichment likely from historical activities on individual parcels (*e.g.*, solder originating from construction or repair of plumbing, electrical systems, or metal structures on the property).

Some slag fragments exhibit Pb inclusions, which present as small Pb formations within the alumina-silicate matrix of the surface layer. The morphological and compositional variability of these slags is consistent with multiple sources.

Coal and coke are widely observed throughout the AOC study area. Although most of these particulates do not contain Pb and As, they indicate the presence of fill.

Selected samples of slag, coal, ash, and soil minerals exhibited small particles of Pb less than 10 um adhered to their surfaces. While it is possible that these Pb particles were atmospherically distributed at one time, they occur throughout the fill layers and are not uniformly observed on adjacent soil or fill particles. Consequently, the spatial distribution of these Pb deposits is consistent with coal exposed to Pb prior to emplacement on the residential property from which they were sampled. These Pb specks are consistent with emissions from automobiles burning leaded gasoline.

6.4 Fill composition is highly variable and attributable to multiple sources in the study area. Three property excavations in the AOC were photo-documented, and at each excavation multiple fill layers of different character were visible across different depth horizons.

Urban fill layers are clearly evident in the RI soil boring records created by Arcadis and confirmed during site excavation. The fill layers vary in color. Surface loam is typically dark and organic, while deeper fill layers vary in color. The fill layers observed during excavation appeared tan, brown, and black (Figures 10, 11, and 12). Deeper native soil is red likely due to the presence of naturally occurring iron oxides.

Coal ash and cinders are found in discrete shallow layers with varying thicknesses and depth intervals starting within approximately the top 6 inches in many AOC residential properties. The coal ash and cinder material appears most consistently adjacent to roadways and walkways. The

spatial distribution of coal ash and cinders possibly signifies the presence of former roadways or bedding for roads and walkways. It also appears in deeper soils, sometimes co-occurring with wood, brick, and metal fragments like those observed in the front and back yards at 3A Salem St. (Figure 10).

Construction debris occurs in many forms. Brick, cinder block, and lumber fragments are widely observed in the surficial soil layers and much of it is coated in fine soil particles. Rusted iron and steel fragments exhibit 1 mm to 10 mm florets with high proportions of Fe and O and some have Pb impurities. Paint is commonly observed with and without Pb. Construction debris is consistent with urban fill.

Thermogenic and construction debris components of fill are widely observed throughout the study area (Figure 30). Black fragments are typically combustion byproducts and possibly asphalt pavement. Discrete layers of ash, cinder, and vesicular material are segregated when found in relatively pure layers. Construction debris, such as paint chips, solder, and glass are typically mixed with other fill materials.

6.5 Arsenic sources include natural minerals and aqueous deposits most likely attributed to historical use of arsenic-containing pesticides.

The diffuse nature of As in the study area is consistent with naturally occurring trace elements or historical applications of arsenical pesticides that weathered over time. Extensive analysis for As using SEM-EDS demonstrates that it is not a major constituent of particles comparable to Pb. Rather, the highest concentration of As in soil occurs in an AOC sample containing arsenopyrite - a naturally occurring mineral (Figure 14). Lower As concentrations occur on soil particles composed of ferrous metals to which the As adheres (Figure 15 and 17).

The As deposits in 4143-G16-08-AG-G1881 (Figure 17) are particularly instructive. They closely resemble the penetration of soil particle fractures by aqueous phase As (Figure 9), which are consistent with pesticide applications for insect infestations in agricultural or residential settings. Particle saturation with arsenical pesticides creates exterior and interior As deposits on Fe surfaces and particle fractures. These deposits are distinct from As impurities accumulating in particle emissions released from a copper smelter stack, which would also contain high temperature morphological and compositional features, such as the co-occurrence of O, Fe, Pb and lower abundances of Cu, Zn, Ca, and Al. These data indicate that the most likely source of As in the study area are natural minerals and arsenical pesticides as opposed to copper smelter emissions.

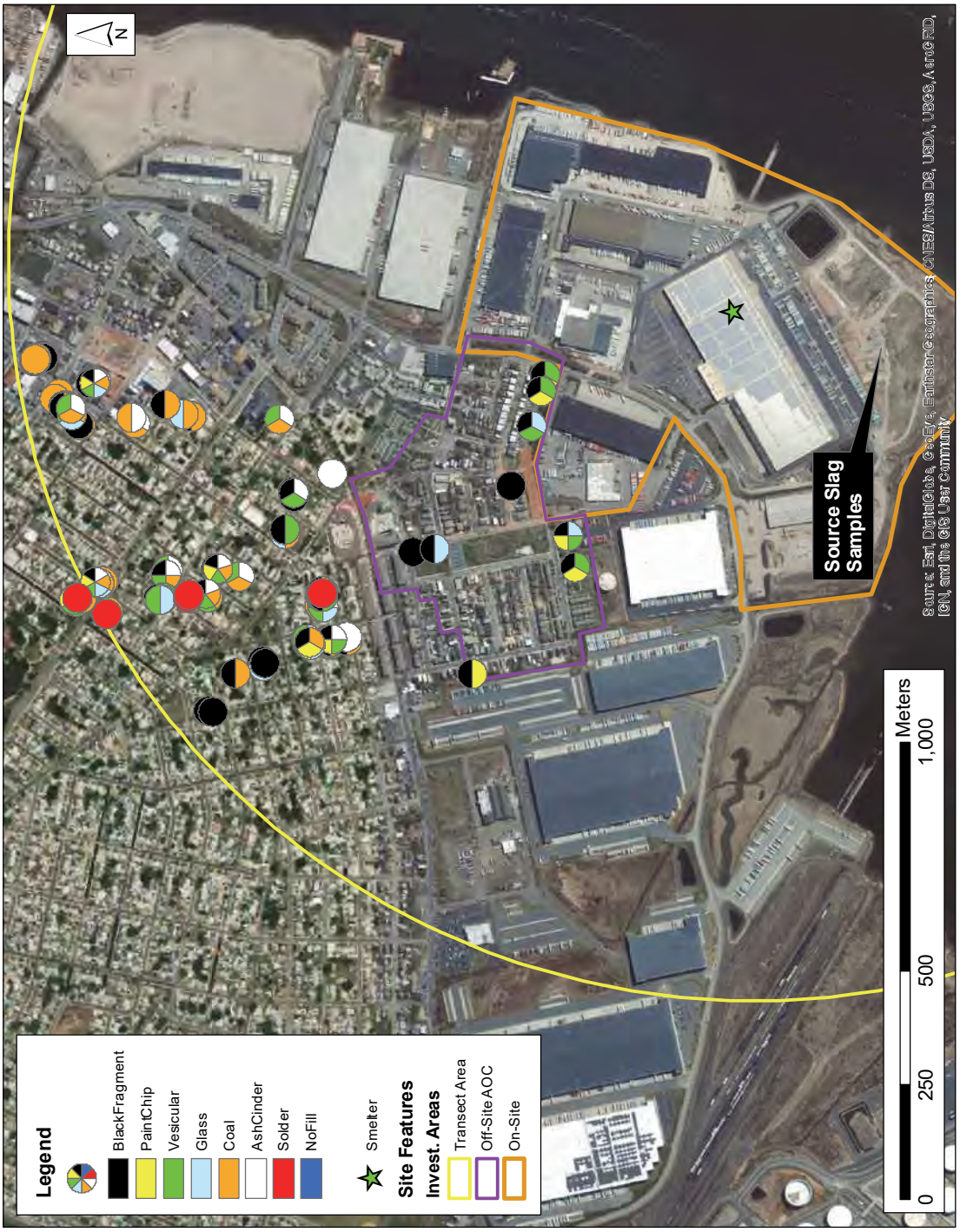

Figure 30. Variable Types of Fill Identified Throughout the Carteret Study Area.

7. References

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STEPHEN D. EMSBO-MATTINGLY, M.S.

Senior Chemist/Consultant

Environmental Forensics Practice

EXPERIENCE SUMMARY

Mr. Emsbo-Mattingly possesses 30 years of forensic chemistry experience. He specializes in the source identification of chlorinated solvents, petrochemicals, dielectric fluids, Askarels, paper mill wastes, petroleum, fuels, tar, heavy metals, coke, coal, carbonization byproducts, hydraulic oils, lubricants, asphalts, combustion byproducts, soot, ash, slag, dusts, emissions, and other industrial products in various environmental media. He has conducted environmental chemistry and forensic investigations at electric utilities, power plants, electrical substations, paper mills, smelters, dry cleaners, chemical plants, chlorinated solvent manufacturers, service stations, petroleum storage facilities, petroleum refineries, metal refineries, marine terminals, wood treating facilities, tar refineries, transformer recycling operations, mining operations, coke plants, former manufactured gas plants (MGPs), smelters, railroads, power plants, and metallurgical operations. He directs and manages forensic chemistry projects throughout the United States involving the identification of fugitive products containing dust, radioisotopes, chlorinated volatile organic compounds (CVOCs), organochlorine and organophosphorus pesticides, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDFs), petroleum hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), per- and polyfluoroalkyl substances (PFAS), geochemical biomarkers, synthetic polymers, resins, organometallic compounds, radioisotopes, stack emissions, and other anthropogenic materials.

Mr. Emsbo-Mattingly drafted the most comprehensive forensic delineation of impacts from the Deepwater Horizon Oil Spill in nearshore environments. Other forensic projects focus on regional- and local-scale releases, which often require a detailed evaluation of historical process chemistry and environmental results. The process chemistry refers to the historical reconstruction of the site operations that potentially generated or distributed the contamination. Careful consideration of off-site and non-point releases from urban background or regional storm sewers play significant roles in projects with contaminant concentrations approaching ambient background. Many forensic investigations also required detailed study design, workplans, sample collection, and analysis of laboratory data and quality control performance. Mr. Emsbo-Mattingly's past technical and expert reports were commissioned on behalf of both private companies and regulatory agencies. They have featured numerous emerging forensic methods (chlorine and carbon isotopes, gas-phase forensics, organic petrology, stereomicroscopy, scanning electron microscopy, energy dispersive x-ray spectrometry, compound-specific isotope ratio mass spectrometry, hydrocarbon soluble metals, Fourier transformed ion cyclotron resonance mass spectrometry) and interpretive techniques (chemometrics, geostatistical, and data visualization software tools).

As indicated below, Mr. Emsbo-Mattingly's recent publications focus on the differentiation sources of chlorinated organics, tar, petroleum, and solvents in non-aqueous phase liquids (NAPLs), sediment, soil, tissue, and air media. Prior to joining NewFields Mr. Emsbo-Mattingly was a Principal Research Scientist at Battelle Memorial Institute after directing the operations of the META forensic laboratory and the E3I full service environmental laboratory. He is currently the managing partner of NewFields Environmental Forensics Practice, LLC.

EDUCATION AND TRAINING
M.S., Environmental Science, University of Massachusetts, 1994
B.A., Biology, Oberlin College, 1988

EMPLOYMENT HISTORY

Energy & Environmental Engineering (E3I): 1988 to 1996
META Environmental, Inc. (META): 1996 to 2000
Battelle Memorial Institute (BMI): 2000 to 2004
NewFields Environmental Forensics Practice, LLC (NF): 2004 to Present

PROFESSIONAL AFFILIATIONS

American Chemical Society
Society of Environmental Toxicology and Chemistry
Air and Waste Management Association
American Wood Protection Association
Society for Industrial Archeology

REPRESENTATIVE PROJECT EXPERIENCE

Microscopy

Former Metallurgy Plant – A metallurgical operation that specialized in the manufacture of "I" beams operated on the site of a former refinery. Lead concentrations in surface soil were initially attributed to the manufacture of leaded gasoline by the refinery. However, polarized light microscopy (PLM) and scanning electron microscopy equipped with energy dispersive spectroscopy (SEM-EDS) particle morphology and elemental composition conclusively demonstrated that the lead was by-spray from the application of rust resistant coatings, such as "Red Lead."

Municipal Landfill Site – Heavy metals were detected in surface soils at a municipal landfill. A soil boring program employed a hand-held visible light digital microscope to differentiate loam and ash layers among a large number of field samples. Representative samples were shipped to the microscopy laboratory for PLM and SEM-EDS analyses, which demonstrated the co-occurrence of lead and other heavy metals with industrial ash deposits.

Byproduct Coke Oven Plant – A byproduct coke oven plant constructed during World War I generated large piles of coke breeze – a fine particulate form of coke. Elevated concentrations of PAHs in proximal sediments were initially attributed to coke breeze. A forensic investigation demonstrated that the chemical fingerprint of coke breeze was not consistent with the PAHs in sediment. The microscopic organic petrology method data conclusively demonstrated that coke breeze particles could not account for more than 1% of the particles in each sediment sample.

Coal Dust – Contaminant exposure from coal dust proximal to rail lines conveying long trains of coal hoppers became a concern when EIS studies focused on the construction of new, high-volume coal export ports in the Pacific Northwest. Past investigations demonstrated that trains generate ephemeral plumes of particulate matter (PM2.5 and PM10) when trains travelled across Washington State with coal from the Powder River basin in Wyoming, but the extent and composition of these particulate plumes were unknown. NewFields was hired to apply state-of-the-art particle tracking technologies to delineate the dust plume and determine the coal-derived contribution of contaminants at specific distances from the track. At multiple locations throughout the state, NewFields constructed transects perpendicular to the track equipped with summa canisters for VOCs, high volume cascade impactor samplers for PAHs, TPH, and metals; and electrostatic low pressure impactors (ELPIs) for high resolution particle fractionation for microscopic characterization (organic petrography, polarized light microscopy [PLM], scanning electron microscopy-energy dispersive x-ray spectrometry [SEM-EDS]). DustTrak aerosol monitors ran concurrently to assure that the results from this study could be connected to the larger body of PM data generated by other researchers. This was the first study to definitively quantify the proportions of mineral matter from ambient air, re-suspended matter from the track, and coal dust emissions from the train. It demonstrated that the volume percentage of coal train dust is approximately 50% mineral matter, 50% organic matter (pollen, spores, fungi, vegetation, and soot), and < 1% coal particles.

Radioisotopes

Age Dating - Radioisotopes are primarily measured during environmental investigations to help constrain the period of contaminant release or confirm the contaminant origin. Radioisotope age-dating is typically accomplished using sediment cores that represent the gradual accumulation of particles over time. Mr. Emsbo-Mattingly reviewed, planned, collected and analyzed more than 100 sediment cores for radioisotope analyses in marine and freshwater environments as part of site investigations, risk assessments and forensic investigations throughout the Americas. The Electric Power Research Institute (EPRI) commissioned Mr. Emsbo-Mattingly to describe the best practices for radioisotope investigations in a guidance document for environmental contaminant dating and natural recovery projects.

Mining and Smelting Waste Delineation - Mr. Emsbo-Mattingly's sediment dating investigations provided information concerning the nature, extent, and mobility of anthropogenic chemicals from point and non-point sources. Radionuclides such as ^{7}Be, ^{137}Cs, ^{210}Pb, ^{210}Po, and ^{14}C helped determine the deposition date of sediment at specific depth intervals and distinguished historical and ongoing organic and heavy metal sources. Additional uranium (U), Pb, thorium (Th), and osmium (Os) nuclides helped distinguish mining wastes from crustal rocks and natural sediment. Radioisotope measurements have been particularly helpful for distinguishing sources of ubiquitous contaminants, like PAHs and metals, that often have multiple natural (e.g., forest fires, volcanoes, and eroded rock), non-point (e.g., regional soot and roadway runoff), and point (e.g., MGP and mining) sources over time.

Solvents and Dry Cleaners

Dry Cleaning – NewFields conducted numerous forensic investigations at former and current dry cleaning facilities. Plumes of PCE and it degradation byproducts (TCE, DCE, and VC) were carefully delineated to identify the point of release, constrain the period of release, and allocate mixed plumes. A detailed examination of solvent by-products and contaminants assisted these investigations.

Avionics, Circuit Boards, and Textiles – NewFields distinguished mixed plumes of PCE and TCE that commingled below a facility that historically supported several distinct operations. The facility initially produced aviation equipment that included a tool shop for metal parts fabrication and a painting facility. The second owner produced circuit boards for aviation equipment that were degreased on site. The third owner manufactured fabrics and textiles, which were dry cleaned on site with PCE before sale. The co-occurrence of chlorinated solvent with kerosene, plasticizers, metals, and synthetic fabric polymers helped differentiate releases from the different site owner/operators.

Automobile Repair Operations – Multiple releases of TCE and PCE occurred historically at an automobile and truck repair facility. Releases within the building consisted of TCE and PCE mixed with cutting oil and paint polymers, while releases behind the building consisted of PCE mixed with motor oil. These chemical and chlorine isotope signatures helped delineate groundwater impacts from the site and distinguish them from an adjacent drycleaner.

YMCA in New York – This investigation focused on the origin of chlorinated solvents and BTEX vapors in an athletic facility. A detailed analysis of the indoor air over time demonstrated that the chlorinated solvents originated from the locker room and maintenance closets. High concentrations of chloroform were traced to the pool area. The detection of 1,3-butadiene was attributed to a false positive.

Pesticide Manufacturers in Brazil – Chlorinated pesticide manufacturers employ a wide range of chlorinated solvents and petrochemicals. The wastes are compositionally varied and include mixtures of solvents and impurities. Undocumented wastes from these operations were found in soils and buried containers at several onsite and offsite locations. Chemical fingerprinting demonstrated that the co-occurrence of the complex solvent mixtures were able to identify the impacts of point sources in NAPL, soil and air.

Metal Product Degreasing Operations – Chlorinated solvents were used in dipping tanks and conveyor belt systems for removing dirt, cutting oils, and pastes from small metal products. Over time, the manufacturing equipment, industrial processes, and discharge practices changed. The preferred degreasing solvents shifted over time between PCE, TCE, and PCA. These shifts corresponded to different types of cutting oil, greases, and film forming compounds such that the periods of release could be distinguished and allocated using chlorinated solvent concentrations, chlorine isotopes, degree of degradation, and co-occuring contaminants.

McKesson Chemical in California – Two neighboring dry cleaning and solvent packaging plants resided above contaminated groundwater. An analysis of chlorinated solvents, degradation byproducts, and petroleum hydrocarbons helped identify the origin of groundwater contamination and migration pathways.

PCB and PCDD/PCDF Projects

New Bedford Harbor - Mr. Emsbo-Mattingly was the project chemist for the New Bedford Harbor (NBH) Superfund Site during 2001. On behalf of USEPA and US Army Corps of Engineers, he helped orchestrate the collection of chemical data (PCBs, PAH, and metals) required for the dredge-design plan. In this capacity, he wrote the NBH Quality Assurance Project Plan and assisted with the NBH Field Sampling Plan. He promoted laboratory compliance with the project objectives through contracting (Statement of Work) and monitoring (Data Review, Data Validation, and Data Interpretation reports) systems.

Centredale Restoration Project –Formerly operated as a chemical manufacturer and drum recycling facility, the historic site activities included waste disposal, which is believed to be the source of PCDDs, PCDFs, hexachloroxanthene, pesticides, and PCB contamination at the site. Collectively, these persistent halogenated organic compounds migrated into proximal waterways. As part of a team lead by USEPA, USACE, and Battelle Memorial Institute, source and reference samples were compared to regional sediments to help confirm the nature and extent of the release. Using chemical fingerprinting and principal components analysis (PCA), Mr. Emsbo-Mattingly helped isolate and track the on-site contaminant signatures down gradient to the point at which they were no longer distinguishable from reference areas.

Wood Treater Project – A former wood treating facility allegedly caused PAH and PCDD/PCDF impacts in neighboring waterways. Historical data including regulatory compliance data were unable to recognize or delineate the chemical signature of source material in proximal sediments. Soils and sediments from the source, reference, and alleged release areas were collected and analyzed by traditional methods with modification for the resolution of numerous additional isomers. The enhanced signature richness and multivariate statistics helped geospatially distinguish site and background related influences.

River in Michigan – Paper mill wastes associated with landfills and historical de-inking operations were allegedly released from multiple facilities into a river in Michigan. A disagreement arose concerning the origin, period of release, and re-mobilization of PCBs attributed to carbonless copy paper. At issue was the reliability of PCB results generated by different methods and the radioisotope data used to estimate the period of release. Mr. Emsbo-Mattingly reconciled the historical PCB Aroclor and congener data and provided guidance on the use of radioisotope sediment dating techniques for determining the period of release and migration of PCBs in the river system.

PCB Superfund Site in Alabama – A former PCB manufacturing facility allegedly released PCB Aroclors into proximal waterways and regional air systems. The transport of this material was

identified by comparison of regional sediments and soils to samples collected around the production facility.

LCP Chemical Superfund Site – PCB impregnated materials were used during the manufacture of caustic soda, chlorine, and hydrochloric acid by the electrolysis of sodium chloride using mercury cells. PCBs and mercury measured in regional sediments were attributed to waste from this manufacturing process. A forensic analysis revealed multiple lines of evidence that suggested a significant portion of the PCBs were attributed to regional background.

Refinery Catalyst – PCB impregnated catalyst was used by a refinery laboratory. Waste catalyst was deposited in a wetland. PCB congener analysis and forensic techniques such as principal components analysis (PCA) were used to demonstrate the local footprint of the catalyst material. Regional sediments, waters, and fish tissue samples exhibited distinct compositional patterns that matched the background dataset.

Aluminum Smelting Plant – Environmental investigations revealed PCB soil contamination associated with the smelting pots. However, a number of Aroclors were identified that were not associated with the process. PCB fingerprinting techniques helped distinguish the Aroclor patterns that were attributed to weathering and those that represented Aroclors used by the plant.

Petroleum Projects

Mr. Emsbo-Mattingly investigated more than 50 petroleum crude oil spills, service stations, petroleum and natural gas production well accidents, refineries, storage depots, pipelines, fracking operations to determine the nature and extent of petroleum releases. These investigations often involved an assessment of historical data, supplemental forensic chemical testing, process chemistry, and applicable background conditions. Many of these projects required geospatial and multivariate analysis of commingled contaminant plumes. The fate and transport of petrochemicals is often characterized using lines of evidence such as hydrocarbon chemistry (PAHs, geochemical biomarkers, saturates), additives (oxygenates, organic lead, scavengers), isotopes, weathering patterns, field data, and many others.

Automotive Service Stations throughout North America - Service stations employ underground storage tanks and pipes for refueling automobiles, trucks, and other internal combustion engines. Contaminant releases are commonly associated with gasoline; however, some sites experience releases of waste oil and degreasing solvents. Mr. Emsbo-Mattingly helped optimized hydrocarbon fingerprinting methods for delineating and age-constraining these releases using chemical fingerprints composed of paraffins, isoparaffins, aromatics, naphthenes, and olefins (PIANO). NewFields customized its testing methods to include additional diagnostic compounds (e.g., thiophenes, gasoline additives, and light biomarkers) and isotopes (carbon, hydrogen, and chlorine) to provide the most powerful source identification capabilities for the widest range of site conditions and forensic objectives.

Deepwater Horizon Oil Spill - The Deepwater Horizon NOAA NRDA oil spill response included multiple nearshore investigations involving the collection of environmental samples between 2010

and 2012 along the coastlines of Louisiana, Mississippi, Alabama, and Florida and proximal waters within 3 nautical miles of the northern Gulf of Mexico shoreline. Nearshore samples consist of soils, sediments, solids, sheens, pom-poms, and tissues. They were chemically analyzed by a network of laboratories. NOAA contracted Mr. Emsbo-Mattingly to help draft multiple field sampling and analytical plans. Once the data were generated, he was further tasked to forensically define the various source signatures of fresh and weathered Macondo oil and forensically compare each sample to the fresh and weathered Macondo oil reference signatures to accurately delineate the natural resources exposed to Macondo oil as a result of the 2010 Deepwater Horizon oil spill. His report identified Macondo oil in 34% of the 5,605 nearshore samples as part of the largest oil spill investigation to date.

Petroleum Storage Terminals - Large petroleum storage terminals are often located in complex urban or industrialized areas with complex piping and storage tanks systems owned by multiple parties. Surface, subsurface and offshore impacts pose many challenges for source identification, source control, and liability management. Mr. Emsbo-Mattingly employed advanced hydrocarbon testing methods to determine if historical product releases occurred from one of several adjacent petroleum terminal facilities located along an industrial canal in central New York. Although the regulatory compliance data (VOC and SVOCs) identified hydrocarbon impacts of indeterminate origin, the high resolution hydrocarbon fingerprinting methods clearly demonstrated that the products in the petroleum terminal were not the origin of contaminants in the proximal sediment.

PAH Source Identification Projects

Mr. Emsbo-Mattingly participated in more than one hundred source identification projects involving the identification of petroleum tar and coal tar generated by carbureted water gas, oil gas, and coke ovens facilities. The historical practices at these sites included the manufacture, storage and distribution of chemical products from former MGPs, wood treatment plants, metallurgical industries, general construction, municipal installations, military bases, utilities and waste sites of many varieties. Several of these projects required the differentiation of releases from adjacent sites that produced and refined tar products, respectively. Often these projects required tracing tar signatures across plumes of independent origin, including background from urban runoff.

Edgewater Tar Refinery Plant – This plant manufactured tar products including Tarvia, Carbasota, creosote, and roofing tar from carbureted water gas and coal tars. Historical tar releases were differentiated from petroleum fuel oil, coal, and waste oil releases using advanced PAH, feedstock, and petrographic fingerprinting. The analysis also included calculations of crude tar consumption and tar product manufacturing rates using historical literature and plant specific records. These findings helped clarify the conceptual site model and resolve the allocation discussions.

West Virginia Coke Plant – The origin of PAHs down gradient of a byproduct coke oven plant and tar refinery was unknown. The alleged sources included coke breeze, coke, coal tar, and refined tar. A detailed characterization of the source materials and downstream soils and sediments demonstrated that the source was attributed to the tar refinery and not the coke breeze, coke, or coal. This finding helped clarify the conceptual site model and resolve the allocation discussions.

Massachusetts MGP Plant – This project focused on the release date and stability of tar residues from an MGP to down gradient sediments. The tar generation rate was estimated from gas production records over time using historical industry literature and site specific information. The fate and transportation analysis required a detailed study of tar weathering and stiffness, which were subsequently related to toxicity studies. The approximate period of release was determined with multiple lines of evidence, which included 1) the manufactured gas plant processes through diagnostic ratios and feedstock analysis and 2) the age of tar containing sediments using radioisotopes.

Ashland/NSP Lakefront Site – The origin of tar throughout this site was not clear. On behalf of USEPA Region 5 and WDNR, Mr. Emsbo-Mattingly employed environmental forensics techniques to demonstrate a pathway for hydrocarbons from a former MGP to the lakefront shoreline. On behalf of the PRP group, he helped identify sections of the Site that were used for wood treating operations.

Sediment Investigations

The Massachusetts Water Resources Authority (MWRA) planned and built a large state-of-the-art wastewater treatment plant to abate the discharge of untreated and partially treated sewage to Boston Harbor. Effluent from the plant is discharged through a pipe running nine miles offshore to further improve the water quality in Boston Harbor and facilitate the dilution of effluent with minimal impact to the offshore environment. MWRA commissioned a comprehensive testing program of Massachusetts coastal sediments to monitor potential impacts of effluent from the Deer Island Plant. Monitoring stations were selected near Boston Harbor and the new outfall (nearfield) and throughout Massachusetts and Cap Cod Bays (farfield). Mr. Emsbo-Mattingly used principal components analysis (PCA) to evaluate compositional changes in selected sediment parameters (pesticides, PCBs, PAHs, metals, TOC and grain size) that occurred during the pre- and post-discharge periods (1992 to 2000 and 2001 to 2002, respectively). He used these same PCA techniques to evaluate changes in zooplankton over the same periods.

U.S. Naval Stations face complex environmental challenges that often arise when bases are closed or redeveloped for civilian activities. Mr. Emsbo-Mattingly participated in multiple shoreline and shipyard assessments for the purpose of identifying and distinguishing environmental impacts from Navy facilities and vessels from urban background and commercial industry. These sediment studies often require traditional chemical fingerprinting coupled with statistical pattern recognition (e.g., principal components analysis or PCA).

Vapor Intrusion Source Identification Projects

Mr. Emsbo-Mattingly participated in more than thirty source identification projects involving the identification of petroleum, tar and chlorinated solvents in urban and residential areas. Central to these investigations is the identification of hazardous chemicals in ambient air resulting from human occupation verses soil gas constituents from vapor intrusion. These projects involved the characterization of volatile compounds from local industries, building materials, ambient air, biological metabolism, and ambient soil gas. These investigations also benefited from advanced air testing methods developed by NewFields that improved the fingerprinting capability of forensic investigations focused on compounds with multiple common origins.

Tar Vapors in NY – The presence of tar byproduct in subsurface soil proximal to a former MGP generated concern about potential vapor intrusion into commercial and residential properties. NewFields worked with the utility and its contractors to rapidly distinguish tar vapors from other subsurface hydrocarbon and halogenated VOC sources. The technical approach included a streamlined process for identifying contaminant exceedances using a traditional TO15 and confirmation using a forensic TO15 method when needed. This approach produced regulatory and source identification reports with accelerated turnaround times.

Chlorinated Solvent Plumes in NJ – Multiple owners and operators manufactured aviation equipment, computer circuit boards, and textiles in an industrial area of NJ. Chlorinated solvents were allegedly used for degreasing, dielectric fluids, paint solvents, and dry cleaning at the site by independent parties. A detailed analysis of chemical patterns in DNAPL, soil, groundwater, and soil vapor demonstrated contributions from each party over time.

Petroleum Product Identification in CA – Several service stations operated near a refinery in CA. The service stations allegedly released gasoline, while the refinery allegedly released multiple light and middle distillate petroleum products. A soil vapor and ambient air investigation demonstrated widespread patterns of halogenated VOCs and BTEX attributed to ambient background with localized and distinct releases from the service stations and refinery, respectively.

Fire Investigations

Natural Coal Fires – Natural coal fires produce coal tar and hazardous emissions. As part of an academic collaboration, NewFields characterized a range of natural coal tars from Kentucky, Alabama, and Wyoming. While the environmental impact of these tars was proximal to the fires, the tar contaminants resembled many of the features of industrial coal tars. The results were published a four volume series on Coal and Peat Fires and the online Encyclopedia of Earth.

Navy Former Fire Training Areas - The impact of former fire training activities is often governed by site-specific factors, like period of operation, confining barriers, soil type, groundwater flow, and accelerant type. The potential influence of these factors was observed to varying degrees in samples collected from multiple sites in Maine and Massachusetts.

Superfund Projects

Neenah MGP Investigation - The site of this former MGP was subsequently occupied by a gasoline service station and other commercial enterprises. Funding for the cleanup was dependent on the identification of non-MGP petroleum residuals at the site that were readily discovered using advanced forensic chemistry methods.

Fairmont Coke Works Site - Black semi-solid material was recovered from a stream dividing two adjacent NPL-listed sites. One site was a coke works site and the other was a tar refining/chemical company. The migration potential of waste material from each site was evaluated in order to clarify the scope of each cleanup under Superfund.

Navy Former Fire Training Area - The impact of former fire training activities is often governed by site-specific factors, like period of operation, confining barriers, soil type, groundwater flow, and accelerant type. The potential influence of these factors was observed to varying degrees in samples collected from this location in Maine.

Heavy Metals

Lead and arsenic exemplify heavy metals that potentially pose risk at low concentrations, sometimes below the ambient background concentrations. Factors that compound the complexity of these investigations include 1) ambient background is often spatially heterogeneous and 2) urban fill can increase the ambient concentrations of ubiquitous contaminants. Mr. Emsbo-Mattingly conducted multiple forensic investigations at complex urban sites for source identification purposes and the derivation of site-specific background concentrations. These projects often included the calculation of site-specific background concentrations attributable to natural geological and urban fill using geospatial statistics, scanning electron microscopy (SEM), energy dispersion X-ray spectroscopy (EDS), polarized light microscopy (PLM), and advanced chemistry including more than 30 metal analytes. Using various combinations of traditional and advanced forensic methodology, Mr. Emsbo-Mattingly differentiated the sources of contaminants attributable to pigments, paints, ceramics, pesticides, metal smelting, and refinery operations.

Projects Commissioned by the Electric Power Research Institute (EPRI)

Project Manager for "Leaching Characteristics of PCB-Contaminated Soils." As project manager, Mr. Emsbo-Mattingly conducted a detailed literature review and a laboratory study of leaching and migration potential of PCBs present at electric utilities. Leaching potential was evaluated for bias using traditional EPA and custom congener-specific methods. Risk-based analytical techniques were developed using toxic equivalency factors (TEFs) that related the relative toxicity of PCB containing samples to a common toxicity scale defined for dioxin. These techniques provided relative scales for evaluating the toxicological impact of PCB-contaminated media.

Project Manager for "Comparative Assessment of Tar Fingerprinting Methods". This project compares traditional and emerging forensic methods for the provision of EPRI members with guidance on their use and applicability to MCP source identification projects. The primary

methods used in this study include gas chromatography/mass spectrometry (GC/MS), gas chromatography/isotope ratio mass spectrometry (GC/IRMS), and Fourier transformed ion cyclotron resonance mass spectrometry (FTICRMS). Data generated from these three methods will be used to determine the advantages and disadvantages of these methods for potentially identifying the extent of tar contamination down to approximately 10 mg/kg total PAH in sediment that are potentially impacted by urban runoff.

Projects Manager for "MGP" Source Characterization, Identification, and Fingerprinting." Mr. Emsbo-Mattingly served as project manager for this contract. His involvement included a detailed literature, field, and laboratory study of the formation, sources, and chemical composition of wastes, such as tars and oils, found at former MGP sites. In addition, this project involved the optimization of analytical methods for the analysis and interpretation of biogenic, pyrogenic, and petrogenic marker compounds.

Project Chemist for "Fate and Transport Study of Preserved Utility Poles." This project focused on the fate and transport of creosote and chlorophenol preservatives in treated utility poles and adjacent soils. Custom analytical methods were developed for the measurement of TPH, PAH, di- through penta-chlorophenols, cresols, quinoline, and carbazole. This project documented the hetergeneous distribution of target analytes in a variety of soil types based on more than 200 pole sites of various ages across the U.S. This study illustrated the complex compositional changes that occur as wood preservatives migrate through the environment and the importance of site-specific factors, like soil type, groundwater, and gravitational transport mechanisms.

Laboratory Quality Control/Quality Assurance

The ExxonMobil Upstream Research Laboratory (URL) is a world class facility that provides integrated geochemical analyses of samples and data collected from potential and active oil production fields in numerous countries. This laboratory has developed and utilized a wide range of testing methods in its pursuit the most accurate and precise data for its clients. In this ongoing process, Mr. Emsbo-Mattingly was commissioned to perform an independent review of its SOPs and QA/QC protocols to gage its capabilities and performance. This evaluation helped identify areas of performance excellence and prioritize areas of method development in a highly specialized niche of the laboratory industry.

Data and laboratory auditor for numerous organic and inorganic laboratories for compliance with prevailing regulatory parameters and project specific quality assurance plans.

Supervised laboratory quality control, laboratory certifications, blind proficiency evaluations, external/internal audits and data validation programs at E3I and META Laboratories. Authored the Laboratory Quality Assurance Plan and numerous QAPP's. Developed protocols for control charts, IDLs, MDLs, and reporting limits. Drafted special methods for PCB, herbicide and petroleum fingerprinting methods. Monitored laboratory compliance with EPA CLP, NYSDOH/DEC ELAP/ASP, and MADEP MCP protocols. Acquired/maintained laboratory certifications in MA, CT, RI, NH, VT and NY.

Analytical Chemistry & Laboratory Operations

Mr. Emsbo-Mattingly developed and implemented custom methods for site-specific data objectives. He consulted with clients interested in atypical methods and performance criteria. He advised clients with respect to legal compliance. He wrote project proposals. He retained final approval for all laboratory activities. He managed production, workflow, personnel, budgets, and long term strategic planning. He coordinated laboratory schedules for the timely completion of analytical projects. He evaluated laboratory operations and data for compliance with CWA, RCRA, CERCLA (CLP), NPDES, MADEP, MCP and MWRA regulations. He supervised personnel, conducted salary and performance reviews.

Mr. Emsbo-Mattingly developed several analytical methods for the analysis of gasoline (PIANO), fuel oil fingerprinting (EPA 8270C Mod.), PCB congeners (EPA 1664 Mod.), and derivatized herbicides (EPA 8150 Mod.). These methods served site-specific project objectives for environmental investigations at gasoline stations, electric power utilities, and chemical manufacturers.

Mr. Emsbo-Mattingly developed several analytical methods for the analysis of Volatile Petroleum Hydrocarbons (VPH) and Extractable Petroleum Hydrocarbons (EPH) as described by the Massachusetts Department of Environmental Protection (MADEP). The VPH/EPH methods were designed to provide a toxicologically meaningful replacement for traditional GC and IR methods for measuring Total Petroleum Hydrocarbons (TPH). At E3I, the implementation of these performance-based methods was centered on Purge and Trap GC/PID/FID, GC/FID and GC/MS. AT META, these methods employed Microscale Solvent Extraction (MSE) techniques followed by GC/MS and GC/FID analyses. Mr. Emsbo-Mattingly's experience with risk-based analytical methods influenced projects in New England, New York, New Jersey, Alaska, and Washington.

Analyzed volatiles (GC/MS/FID/ELCD/PID), semivolatiles (GC/MS/FID), TPH-GC fingerprinting, pesticide/PCB/herbicides (GC/ECD), and metals (ICP) using HP and PE instruments. Executed troubleshooting and maintenance of organic and inorganic instrumentation. Integrated mainframe instrument computer systems with PC-based software. Compiled reports for CLP and commercial clients.

Presentations

[1] "PCE and TCE source identification: a multiple parameter approach." Flanders, K., Emsbo-Mattingly, S., Litman, E., Occhialini, J., Rezendes, A., and Raposo, M. (2017) University of Massachusetts, Amherst, MA. 33st Annual International Conference on Soils, Sediments, Water and Energy, University of Massachusetts, Amherst, MA. October 17-18, 2017.

[2] "MassDEP VPH, EPH, APH Methods Workshop" Emsbo-Mattingly, S.D., Fitzgerald, J., Occhialini, J., Denly, E., Rago, R. 2015. University of Massachusetts, Amherst, MA. 31st Annual International Conference on Soils, Sediments, Water and Energy, University of Massachusetts, Amherst, MA. October 19, 2015.

[3] "Environmental Forensics Workshop" Emsbo-Mattingly, S.D., Litman, E., Flanders, K. 2015. University of Massachusetts, Amherst, MA. 31st Annual International Conference on Soils, Sediments, Water and Energy, University of Massachusetts, Amherst, MA. October 20, 2015.

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